



### D85 Comparison of Methods of Performing Body Height Measurements in Images

Ivo Alberink, PhD\*, Gerda Edelman, and Bart Hoogeboom, MS, National Forensic Institute, Laan van Ypenburg 6, Den Haag, 2497 GB, NETHERLANDS

The goal of this presentation is to compare the performance of two separate methods of performing body height measurements in images.

This presentation will impact the forensic science community and/or humanity by presenting two methods of performing body height measurements in images.

With the growing number of security cameras in the public and private domain, more and more incidents are recorded. In forensic practice, facial comparison of perpetrator to suspects is not always possible, the quality of the images being too poor or the face of the perpetrator not being visible. In these cases it may nonetheless be possible to do an estimation of the body height of the perpetrator. The results can be used to exclude or gather evidence against suspects and as such are interesting to police, judges and lawyers.

In the literature, two methods for doing height measurements in camera images are predominant, both based on photogrammetry (literally: measuring in photographs).

When some a priori knowledge of the scene is available, height measurements can be done on a single image, without the need of camera calibration. Essential for height measurement by *single view metrology* are a reference height of an object in the scene, a set of vertical parallel lines and two sets of horizontal parallel lines (in different directions.) The analysis is based on projective geometry, through the use of so-called *vanishing points*. Together with a reference height, these make it possible to compute a height on the image.

The second method of doing height measurements in images is through the construction of a 3D model of the crime scene, by means of as an example either photogrammetric software or a laser scan. Operators link scene points of the 3D model to corresponding points in the questioned image, which makes it possible to determine position, rotation and focal length of the camera taking the images ("camera match"). Using the retrieved camera information, a virtual camera is placed in the 3D model of the room, looking at the model from the same perspective as the real camera at the real crime scene, and height measurements in the image are performed by placement of cylinders or bipeds (3D models of humans) over questioned persons.

For both of the methods, results need to be validated by doing reconstructions, positioning persons of known height in front of the same camera, under identical circumstances so that comparable reference measurements can be made.

For any height measurement of an operator on a donor, the difference between actual and measured height is assumed to have a normal distribution with a certain systematic bias and variance, both unknown.

Systematic biases result from:

- Loss in height because of the pose of the donor, and
- Inaccuracy of the 3D model and the camera match.

Non-systematic bias of the differences is due to random variation mainly because of human interference (operator effects). On the basis of the readings from the reconstruction, the systematic and random error made in measurements is then modeled and confidence intervals for the questioned person's height can be determined.

Comparison of methods takes place by checking:

1. Consistency of the results and
2. Width of the confidence intervals.

The investigation comprises comparison of the methods in a casework example in which four perpetrators stood in front of two cameras.

#### Body Height Estimation, Photogrammetry, Validation